

## REMARKS

By this Supplemental Amendment, Applicants have amended claims 4, 6, 13, 18, 22, 27, 31, and 36. No new matter has been added. Claims 4 and 6-39 are pending.

In the Office Action, the Examiner rejected claim 11 under 35 U.S.C. § 112, second paragraph; rejected claim 4 under 35 U.S.C. § 102(e) as being anticipated by Lin (U.S. Patent No. 6,093,632); rejected claims 6-10 and 12 under 35 U.S.C. § 103(a) as being unpatentable over Lin in view of Zhao et al. (U.S. Patent No. 6,204,192); and rejected claim 11 under 35 U.S.C. § 103(a) as being unpatentable over Lin and Zhao et al., and further in view of Hung et al. (U.S. Patent No. 6,380,096). In light of Applicants' comments below, Applicants respectfully request reconsideration and withdrawal of all of the rejections, and allowance of the application.

With respect to the rejection of claim 11 under 35 U.S.C. § 112, second paragraph, Applicants have amended claim 11, thereby obviating that rejection. Applicants' amendment to claim 11 is not intended to narrow its scope, and claim 11 should be construed in that light. Accordingly, Applicants respectfully request reconsideration and withdrawal of the § 112, second paragraph, rejection of claim 11.

In the Office Action, the Examiner rejected claim 4 under 35 U.S.C. § 102(e) as being anticipated by Lin. Applicants submit that claim 4, as amended, defines novel and non-obvious subject matter over Lin. Accordingly, the rejection of claim 4 should be withdrawn.

Applicants invention as recited in amended independent claim 4 is directed to an etching method for exposing a layer of Cu by etching a layer of SiN<sub>x</sub> on the layer of Cu with an etching gas constituted of C, H, and F, and O<sub>2</sub>, the O<sub>2</sub> suppressing oxidation of

the layer of Cu while the etching of the layer of SiN<sub>x</sub> occurs, wherein said gas constituted of C, H, and F is CHF<sub>3</sub>.

The Lin reference does not disclose at least an etching method for exposing a layer of Cu by etching a layer of SiN<sub>x</sub> on the layer of Cu including introducing O<sub>2</sub>, the O<sub>2</sub> suppressing oxidation of the layer of Cu while the etching of the layer of SiN<sub>x</sub> occurs. The Examiner acknowledges Lin's failure to disclose all of the subject matter recited in Applicants' amended claim 4 by asserting "Lin does not teach the inclusion of oxygen in the nitride etching gas." Office Action at 3. The Examiner, however, asserts that the Zhao et al. reference discloses "etching a nitride layer with a mixture of a fluoromethane and oxygen," and concludes that "[i]t would have been obvious to one skilled in the art to add the oxygen of Zhao's nitride etch into Lin's fluoromethane based etch [sic] the nitride layer because Zhao teaches that it is conventional to include oxygen (column 4, lines 32-34)." Id.

Notwithstanding the Examiner's assertion about what the Zhao et al. reference discloses, Applicants respectfully traverse the Examiner's conclusion that it would have been obvious to add oxygen into Lin's fluoromethane etch because there is no legally proper suggestion or motivation to modify the Lin process in the hypothetical manner proposed by the Examiner. In order to modify a reference or combine reference teachings, "there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art." M.P.E.P. § 2143. And "[t]he mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." § 2143.01 (emphasis added) (citation omitted). Therefore, since neither the Lin reference nor the Zhao et al. reference provide any

suggestion or motivation for modifying the Lin process in the hypothetical manner proposed by the Examiner, there is no legally proper reason to make the Examiner's proposed hypothetical modification.

As outlined previously herein, the Lin reference does not disclose an etching method for exposing a layer of Cu by etching a layer of SiN<sub>x</sub> on the layer of Cu with an etching gas constituted of C, H, and F, and O<sub>2</sub>, the O<sub>2</sub> suppressing oxidation of the layer of Cu while the etching of the layer of SiN<sub>x</sub> occurs. The Zhao et al. reference fails overcome that acknowledged deficiency of the Lin reference.

The Zhao et al. reference discloses a silicon nitride layer 40 formed over a low dielectric constant (low-k) insulation material 30, which is formed over a copper interconnect layer 20. Col. 4, lines 17-28. Zhao et al. discloses etching the silicon nitride layer 40 using a CHF<sub>3</sub> and O<sub>2</sub> plasma, and etching the low-k insulation layer 30 using a silicon oxide etchant system such as a CF<sub>4</sub> and H<sub>2</sub> plasma, or a CF<sub>4</sub>, C<sub>4</sub>F<sub>8</sub>, and argon plasma. In other words, the Zhao et al. silicon nitride layer 40 is not on the copper layer 20, and the Zhao et al. CF<sub>4</sub> and H<sub>2</sub> plasma is not used to expose the copper layer 20. Instead, the CF<sub>4</sub> and O<sub>2</sub> plasma merely exposes the Zhao et al. low-k insulation layer 30. In fact, the Zhao et al. reference actually teaches away from exposing a copper interconnect layer using a CF<sub>4</sub> and O<sub>2</sub> plasma because Zhao et al. switches etchant gas prior to etching the layer (the low k insulation layer 30) above the copper interconnect layer 20. Accordingly, the Zhao et al. reference does not provide any legally proper suggestion or motivation to make the Examiner's proposed hypothetical modification to the Lin process. Therefore, the Lin reference and the Zhao et al. reference, taken singly or in combination, fail to either disclose or suggest Applicants' invention as recited in amended independent claim 4.

Furthermore, neither the Lin reference nor the Zhao et al. reference, taken singly or in combination, discloses or suggests a processing gas including O<sub>2</sub> for suppressing oxidation of the Cu layer while the etching of the SiN<sub>x</sub> layer occurs. The Lin reference does not even acknowledge that a copper interconnect layer may be adversely affected by oxidation, and the Zhao et al. reference, as outlined above, does not disclose using O<sub>2</sub> in an etching processing gas to etch a layer over a copper layer. Therefore, in addition to there being no legally proper suggestion or motivation to modify the Lin process in the hypothetical manner proposed by the Examiner, the Lin and Zhao et al. references, taken singly or in combination, fail to disclose all of the subject matter recited in Applicants' amended independent claim 4. Accordingly, Applicants respectfully submit that amended independent claim 4 should be allowable.

In the Office Action, the Examiner rejected claim 6 under 35 U.S.C. § 103(a) as being unpatentable over Lin in view of Zhao et al. Applicant has amended claim 6, thereby obviating that rejection. To the extent, however, that the Examiner may reassert that rejection against amended claim 6, Applicants respectfully submit that, as outlined above, there is no legally proper suggestion or motivation to modify the Lin process in the hypothetical manner proposed by the Examiner.

Applicants invention as recited in amended independent claim 6 is directed to an etching method for exposing a layer of Cu by etching a layer of SiN<sub>x</sub> on the layer of Cu, wherein a step in which a processing gas containing a gas constituted of C, H, and F, and O<sub>2</sub> is raised to plasma and an SiN<sub>x</sub> layer on a Cu layer is etched using a photoresist layer having a specific pattern formed therein, thereby exposing the Cu layer. The etching method further includes a step in which H<sub>2</sub> is introduced into the processing chamber and an H<sub>2</sub> plasma process is implemented on the Cu layer that has

become exposed by raising the H<sub>2</sub> to plasma while removing C atoms and F atoms introduced into the Cu layer that has become exposed during etching.

The Lin and Zhao et al. references, taken singly or in combination, fail to disclose or suggest at least an etching method for exposing a layer of Cu by etching a layer of SiN<sub>x</sub> on the layer of Cu, wherein a step in which a processing gas containing a gas constituted of C, H, and F, and O<sub>2</sub> is raised to plasma and an SiN<sub>x</sub> layer on a Cu layer is etched using a photoresist layer having a specific pattern formed therein, thereby exposing the Cu layer. For at least reasons similar to those outlined above with respect to claim 4, there is no legally proper suggestion or motivation for making the Examiner's proposed hypothetical modification to the Lin process. Furthermore, neither the Lin reference nor the Zhao et al. reference discloses implementing an H<sub>2</sub> plasma process on the Cu layer that has become exposed to remove C atoms and F atoms introduced into the Cu layer that has been exposed during etching. Thus, the Lin and Zhao et al. references, taken singly or in combination, fail to disclose all of the subject matter recited in Applicants' amended independent claim 6. Accordingly, Applicants respectfully submit that amended independent claim 6 should be allowable.

Applicants' invention as recited in amended independent claim 13 is directed to a method for etching an SiN<sub>x</sub> layer on a Cu layer of a workpiece placed inside a processing chamber. The method includes introducing a processing gas comprising C, H, and F, and O<sub>2</sub> into a processing chamber, the O<sub>2</sub> suppressing injection of C atoms and F atoms of the processing gas into an exposed portion of the Cu layer while the SiN<sub>x</sub> layer is etched, and raising the processing gas introduced into the processing chamber to plasma to etch the SiN<sub>x</sub> layer such that the portion of the Cu layer is exposed.

The Lin reference and the Zhao et al reference, taken singly or in combination, fail to disclose or suggest at least a method for etching an SiN<sub>x</sub> layer on a Cu layer of a workpiece placed inside a processing chamber, including introducing a processing gas comprising C, H, and F, and O<sub>2</sub> into a processing chamber, the O<sub>2</sub> suppressing injection of C atoms and F atoms of the processing gas into an exposed portion of the Cu layer while the SiN<sub>x</sub> layer is etched. Therefore, Applicants amended independent claim 13 should be allowable.

Applicants' invention as recited in amended independent claim 22 is directed to a method for etching an SiN<sub>x</sub> layer on a Cu layer of a workpiece placed inside a processing chamber. The method includes introducing a processing gas comprising C, H, and F, and O<sub>2</sub> into a processing chamber, the O<sub>2</sub> suppressing oxidation of an exposed portion of the Cu layer while the SiN<sub>x</sub> layer is etched, and raising the processing gas introduced into the processing chamber to plasma to etch the SiN<sub>x</sub> layer such that a portion of the Cu layer is exposed.

The Lin reference and the Zhao et al reference, taken singly or in combination, fail to disclose or suggest at least a method for etching an SiN<sub>x</sub> layer on a Cu layer of a workpiece placed inside a processing chamber, including introducing a processing gas comprising C, H, and F, and O<sub>2</sub> into a processing chamber, the O<sub>2</sub> suppressing oxidation of an exposed portion of the Cu layer while the SiN<sub>x</sub> layer is etched. Therefore, Applicants' amended independent claim 22 should be allowable.

Applicants' invention as recited in amended independent claim 31 is directed to a method for etching an SiN<sub>x</sub> layer on a Cu layer of a workpiece placed inside a processing chamber. The method includes introducing a processing gas comprising C, H, and F, and O<sub>2</sub> into a processing chamber, the O<sub>2</sub> suppressing oxidation of an

exposed portion of the Cu layer and suppressing injection of C atoms and F atoms of the processing gas into the exposed portion of the Cu layer while the SiN<sub>x</sub> layer is etched. The method further includes raising the processing gas introduced into the processing chamber to plasma to etch the SiN<sub>x</sub> layer such that a portion of the Cu layer is exposed.

The Lin reference and the Zhao et al reference, taken singly or in combination, fail to disclose or suggest at least a method for etching an SiN<sub>x</sub> layer on a Cu layer of a workpiece placed inside a processing chamber, including introducing O<sub>2</sub> into the processing chamber, the O<sub>2</sub> suppressing oxidation of an exposed portion of the Cu layer and suppressing injection of C atoms and F atoms of the processing gas into the exposed portion of the Cu layer while the SiN<sub>x</sub> layer is etched. Therefore, Applicants' amended independent claim 31 should be allowable.

The other cited reference, Hung et al., fails to overcome the deficiencies of the Lin and Zhao et al. references.

Accordingly, Applicants respectfully submit that amended independent claims 4, 6, 13, 22, and 31 are allowable. Furthermore, Applicants submit that claims 7-12, 14-21, 23-30, and 32-39 are allowable by virtue of their dependency on claims 6, 13, 22, and 31, respectively, as well by their additional recitations of novel and non-obvious subject matter. Therefore claims 4 and 6-39 should be allowable.

Applicants respectfully request the reconsideration and reexamination of this application and the timely allowance of the pending claims.

If the Examiner believes that a telephone conversation might advance prosecution, the Examiner is cordially invited to call Applicants' representative at 571-203-2739.

Applicants respectfully submit that the Office Action contains numerous assertions relating to the related art and the claims. Regardless of whether those assertions are addressed specifically herein, Applicants decline to automatically subscribe to them.

Please grant any extensions of time required to enter this response and charge any additional required fees to our Deposit Account No. 06-0916.

Respectfully submitted,

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